AD 77449

Armed Services Technical Information Agency

Reproduced by
DOCUMENT SERVICE CENTER
KNOTT BUILDING, DAYTON, 2, OHIO

CONFIDENTIAL

CONFIDENTIAL FC

NRL Report 4642
Copy No.

TWO-HELICOPTER ATTACK SYSTEM

[CONFIDENTIAL TITLE]

L. C. Ricalzone and C. A. Matthes

Sound Division
Airborne Sonar Branch
Engineering Section

OCT 14 1955

NAVAL RESEARCH LABORATORY
Washington, D.C.

DEC 6 1955

CONFIDENTIAL

CONTENTS

ABSTRACT

Because of the development of the modern high speed submarine, capable of high submerged speeds and prolonged submergence, along with the great vulnerability of surface ASW vessels to submarine attack, it became desirable to develop an antisubmarine attack system suitable for a vehicle which possesses a high mobility and comparative invulnerability to submarine attack. To meet this need the Naval Research Laboratory has developed and field-tested the NRL Two-Helicopter Attack Sonar System. Continued field research and development has been conducted for the past two years, in which new techniques were evolved and exploited. Results of these field tests have shown that this system is capable of: Excellent short range classification, presenting precise sonar information for fire control equipment, accurate vectoring of a transponder carrier to a target, a probable increase in hit percentages with both active and passive ASW weapons, and it requires a minimum amount of sonar operator training because of the pictorial presentation.

PROBLEM STATUS

This report is a final summary report which includes much of the information previously reported. Some of the techniques developed under this problem are being considered for application under another problem.

AUTHORIZATION

NRL Problem S05-08
BuAer Problem EL-46001
Project Nos. NR 585-080 and NL 430-014-3

Manuscript submitted September 12, 1955

TWO-HELICOPTER ATTACK SYSTEM

INTRODUCTION

Because of the development of the modern high speed submarine, capable of high submerged speeds and prolonged submergence, along with the great vulnerability of surface ASW vessels to submarine attack, it became desirable to develop an antisubmarine attack system suitable for a vehicle which possesses a high mobility and comparative invulnerability to submarine attack. The most desirable vehicle for this use is the ASW helicopter. With this in mind, the Naval Research Laboratory has developed and field tested the NRL Two-Helicopter Attack Sonar System.

The major objective of this effort was the development of a system which would yield more complete information about a sonar contact with accuracies considerably higher than those available in fleet airborne sonar equipment and to develop the technique of underwater guidance to the target of a transponder towed from a second helicopter. Field trials of this system have shown its high location accuracy of the transponder with respect to target, simple transponder vectoring procedure, good target classification ability at ranges to about 1,200 yards from the aspect and highlights displayed by the SSI, good submarine depth information from surface echo, and submarine course and aspect information from the SSI.

This system makes use of two helicopters, one to carry the SSI type classification and attack sonar, the other a sonar transponder and ordnance. The sonar system carried by number one helicopter is designed around a Sector Scan Indicator (SSI), a device which scans the sound beam of the transducer, indicating the true position of the targets within the sound beam. By the use of the SSI and short sonar pulses, target range and bearing can be accurately obtained, and, under certain conditions, at short ranges (1,200 yards or less for this beamwidth) target course, target length, target depth and target aspect. The following figures demonstrate the theoretical concept of this system. Figure 1 states the assumptions that initial detection is made from either aircraft, radar, long range sonar or helicopter screen. When such detection is made, helicopter No. 1 is sent out to establish contact for classification and attack. After target classification, the sonar-carrying helicopter calls the ordnance- and transponder-carrying helicopter in for the attack (Fig. 2).

The No. 2 helicopter is directed to launch and tow the sonar transponder within the sound beam of helicopter No. 1 at a position somewhere near the target. No. 1 then obtains a sonar plot on his SSI display of the position of the sonar transponder with respect to the submarine target. From this display, helicopter No. 2 is voice-vectored in on the true sonar bearing of the target until there is coincidence of the target and transponder echoes, Fig. 3. At this point, helicopter No. 2 is positioned near the target and is instructed to release his ordnance. Any escape maneuver by the target is quickly observed by helicopter No. 1 and corrective information is radioed to Number 2 to reduce the probability of escape. The helicopter with its high mobility can readily move in any direction as corrective instructions are received. This type of attack system is free from errors due to thermal gradients and other water effects since both the target echo and transponder echo suffer equally from these effects, cancelling these errors.

This system divides the classification-tracking functions and attack function between two separate helicopters. Some of the advantages of this approach are:

a. Weight division of sonar and weapons system reduces the load per vehicle.
b. Conversion of load reduction per vehicle into on-station-time.
c. Use of a sonar-carrying helicopter to vector the weapon-carrying helicopter to the target is believed simpler and more accurate than having the sonar-carrying helicopter vector itself to the target.
d. If the weapon-carrying helicopter can be vectored over the target, a simple contact or influence type ordnance can be used with a resultant saving in weapons cost or at least should result in optimum position for active torpedo drops which should produce a higher hit probability. Also by using a simple weapon, more weapons can be carried making more re-attacks possible.

SYSTEM DESCRIPTION

A brief description of the Sonar Systems and transponder will be given here; for a complete engineering description of this system see NRL Memorandum Report No. 349 "Two-Helicopter Attack System". This equipment is a Laboratory experimental model as opposed to a prototype. The fabrication techniques were developed with ease of modification and development in mind, in order to permit major changes and improvements to be made in the field as results indicate their desirability.

The electronic portion of the sonar system operating at 20 kc (Fig. 4) consists of a 650-watt driver capable of providing pulse-lengths of from 0.1 to 100 milliseconds, an audio receiver of 500-cps bandwidth, an SSI receiver having a variable bandwidth of from 500 to 5000 cps, the display console, and the power unit which contains the dynamotors necessary to power the system. A simple doppler indicator was also incorporated. The SSI receiver employs NRL circuitry modified for airborne use. It presents the true position of the target in the sound beam by giving a wedge-shape visual presentation which approximates the shape of the sound beam. Headphone aural presentation is also provided.

Two types of transducer-handling mechanisms were developed for this system, one the hydraulically operated reel and flat cable (Fig. 5) and the other the "sonar boom", a 50-foot articulated strut hoisted by the rescue winch cable. Fig. 6 is a series of photographs of flight tests of a model of the sonar boom and a dummy transducer. The transducer-training mechanism for the flat cable suspension consisted of a modified AN/AQS-4 bell housing and training system; for the "boom" suspension the transducer was trained from within the helicopter through the torsionally rigid boom by a modified P-1 autopilot equipment.

The transducer used in this system is composed of one-half-wave-length ADP crystals backed with corprene in a 14-inch array, split for SSI use. The electrical characteristics are: resonant frequency 20 kc; beamwidth at the -10 db points, 26 degrees; efficiency, 48 percent; directivity index 21.6 db. With the system's driver, the transducer has a source level of 115 db above 1 microbar at one yard on the axis.

The over-all weight of this laboratory type Sonar System is 468 pounds with the flat cable type suspension.

The electronic portions of the transponder equipment (Fig. 7) consists of a receiver, trigger circuits, and a driver capable of an electrical output of 100 watts at pulse lengths of from 1 to 50 milliseconds. A power unit consisting of two dynamotors is used to power the electronic equipment. A standard helicopter rescue winch with modified drum is used in launching, towing, and retrieving a small towed-body which houses the transponder transducer. A depth gauge is provided for transducer depth and a strain gauge is provided to indicate tow-line tension. The total weight of the experimental transponder equipment is 200 pounds. The transponder-handling configuration is illustrated

in Figure 8, which shows the helicopter in a hover and ready to launch the transponder. The towing cable has a swaged ball at the preset towing depth which engages the towing "hook". The hook can be seen just above the towed body. When the ball engages the hook, the towing strain is taken by a stable tow point aft of the engine, leaving the cable slack from the hook to the drum.

OPERATIONAL FIELD TESTS

Initial Flight Tests

Initial flight tests of this system were attempted in the Key West area with the assistance of Air Development Squadron One, under Assist Project Bu/V77/S68 during August and September 1953. The Attack System, using the sonar boom and the transponder were installed on two HRP-1-type helicopters for these tests. During towing tests of the transponder towed-body, the fish broached, possibly owing to instability of this particular fish at speeds in excess of 15 knots, and on re-entry in the water parted the tow cable, which destroyed the after rotor of the helicopter causing it to crash in 200 feet of water with loss of both the helicopter and transponder equipment. Difficulty was also encountered in the mechanical flight tests of the sonar boom which was being used as the handling mechanism for the sonar transducer. Lowering and training of the boom was satisfactory. However, on hoisting, the boom, for unknown reasons, tended to raise at right angles to the helicopter. Because of these and other operational difficulties, tests were suspended without the collection of any sonar data on the system.

Second Field Tests

The Sonar Systems transducer was installed on the ship's three-axis-stabilized mount which gave a transducer depth of only 10 feet. This is very shallow compared to a helicopter-borne transducer, a fact which appeared in the results as reduced sonar ranges. In addition, the transducer had to "look" through both an inner and an outer sonar dome, which caused some attenuation and resolution loss. Of interest during this test phase was the use of a dual-track Ampex Magnetic tape recorder as a means of storing the system's video, audio, and reference voltages. This technique allowed a very detailed and careful examination and playback of actual field data.

The second field tests of this system were made during the period of 21 May through 11 June 1954 with the assistance of Air Development

Squadron One under Assist Project Bu/V77/S68 in the Key West area. For these tests, the Sonar System was installed on the E-PCE(R) 851. Two transponders were used, one installed on the AVR 77449, and the other on an HRF-1 type helicopter (Bu. No. 111621). A surface ship was used as the carrier for the sonar system because of the unavailability of helicopters for this type of ASW development. The use of a surface carrier for these tests was advantageous since it: (1) Allowed more operational time than was possible from a helicopter, (2) allowed the making of adjustments on the equipment while operating, and (3) allowed the carrying of adequate instrumentation to collect sonar data for later study in the laboratory. By using two transponder carriers, continuous operations were possible. When the helicopter was on station, the AVR acted as plane guard; when the helicopter returned to base for fuel, the AVR towed the transponder as directed by the sonar ship.

Submarine Target Operations — During the period of 1 - 10 June 1955, vectoring operations were conducted on seven of the eignt operating days. The target was the USS MANTA (AGSS 299) operating on a given course, at three knots, at a depth of 150 feet in an area where the water depth was 600 feet. This target depth was necessary to insure that the towed transponder body would not become entangled with the target. Unfavorable BT conditions encountered for this submarine depth (Fig. 9) combined with the shallow sonar transducer depth limited the maximum sonar range from 500 - 800 yards. These short, assured ranges, made vectoring operations from a surface ship very difficult, because of the limited maneuvering range before losing sonar contact. On two of the seven operating days, when maximum sonar range was 400 yards, it was found impossible to maintain the submarine within sonar contact range and to conduct vectoring tests at the same time. The submarine was surfaced and sonar echoes were obtained to a range of 1500 yards showing the effect of the shallow ducts and the thermal gradients. The BT conditions also caused erratic operation of the transponder at the more desirable vectoring ranges of 600 - 800 yards. Because of these facts, only nine valid attack runs were made, five using the helicopter transponder and four using the AVR transponder. These runs were carried out by establishing sonar contact with the target submarine, then positioning the transponder carrier in the sound beam in such a way that an echo would appear from both the target and transponder. During these tests, the towing speed of the helicopter was limited to 7 knots for safety, and the towing speed of the AVR to 8 knots for practical reasons. The transponder was vectored by voice radio to the target by directing the course of the transponder carrier to cause coincidence of the transponder and target echoes (Fig. 10). When coincidence was obtained, the target was ordered to fire an air slug and smoke pot, and the transponder carrier to fire a dye marker.

Results - Second Operation -- The attack runs were evaluated by personnel from VX-1, E-PCE(R) 851, and NRL by observing the relative positions of the dye marker, air slug, and smoke pot. From these observations four of the runs were classified as direct hits suitable for contact ASW weapons and all nine runs as certain Mark 43 torpedo hits. Figure 11 is a photograph of an actual attack run (photographed from the remote indicator). It shows the SSI presentation with the transponder progressing up the screen, coincident with target, and finally passing beyond the target, with the target at the marginal range of 800 yards for that day. In actual operation, the transponder echo can be given a doppler shift of about 50 cps from the target and reverberation frequencies which makes its recognition much more definite than is evident from these photographs. As can be seen from the photographs, the precision of the attacks suffered considerably from the fact that they had to be carried out at near the maximum sonar range of the day in order to provide adequate maneuvering area for the ship, the crash boat, and the helicopter. It is believed that if two helicopters had been used for this system, the submarine could have been kept at a more favorable sonar range where the target and transponder would have presented clear-cut echoes as shown in Figure 12. Under these conditions, target aspect is clearly observable, making it possible to vector the transponder to a particular part of the target. Further it is believed that with a helicopter platform where the sonar transducer could be lowered to a depth of at least 60 feet and in more favorable water conditions, reliable attacks could be made to sonar ranges of 1200 yards where the target loses its aspect and approaches a point source as far as this system's SSI is concerned.

These tests also served to illustrate the short-range classification capabilities of the SSI. At ranges below 800 yards, target aspect, target course, target length, and highlight echoes were consistently obtained. At aspects within 15 degrees of beam, surface echoes were obtained indicating a target depth of 125 feet on a target 150 feet deep, the vertical echo point being 25 feet above the target submarine's keel. Figure 13 shows photographs of typical surface-echo presentations from the SSI. Figure 14 shows the type of presentation obtained on the SSI from various aspect angles at ranges of 400 - 600 yards with pulse lengths of 3 - 5 milliseconds. Target highlight echoes are obtained by reducing the video gain to a point where only the strongest hull echoes are observable. Figure 15 shows highlight echoes from a submarine target at a range of 600 yards. Target length was consistently measured with this system as 270 - 280 feet which is the approximate pressure hull length. When all this information is obtained from a target, it can be definitely classified as a submarine target, and all necessary attack information is provided.

Third Operation

The final operational field tests were conducted from 21 February to 11 March 1955 with the assistance of Air Development Squadron One in the Key West area. For these tests both the main sonar set and transponding equipment were installed on surface carriers, the E-PCE(R) 851 and on an AVR-type crash boat because no helicopters were available. Because of low priority, only a few hours of submarine services were obtainable and therefore a synthetic sonar target, a triplane structure, was used at a depth of 40 feet for data collection. Approximately 65 feet of tow cable was used for the transponder, which resulted in a transponder depth of approximately 40 feet. For these tests, a high-speed fish had been designed and constructed (Fig. 16). Basically, this fish was of the DTMB disc-nose design capable of steady hydrodynamic behavior at speeds of 30 knots. In general, the sonar conditions encountered were poor to fair as are shown in the BT slides in Figure 17. Fifty-nine data runs were made which consisted of the AVR transponder carrier opening and closing the range to the triplane target and of measuring the distance from the AVR to the triplane buoy with an optical range finder when the buoy was abeam of the AVR. This same distance was measured by the Attack System on the E-PCE(R) -51 from presentations on the system's CRT indicator. A comparison of these two measurements led to the determination of the position location accuracy of this system. Five different sonar operators were used, two naval aviators and three NRL engineers.

A subsequent laboratory analysis of the collected field data indicated there had been performed a total of 59 valid attack runs. Of this total 76% were within a 10 yard error. This error or "miss range" was the difference between the distance from the AVR to triplane buoy as measured optically and the distance from transponder to triplane as measured with sonar. It should be made clear that when the AVR approached the triplane, it attempted to maintain a steady course and therefore it was assumed that the horizontal distance from the AVR to triplane and transponder to triplane were essentially identical as each passed the triplane.

Figure 18 is a histogram of Percentage of Total Runs versus Error-Yards. From this figure, it is evident that 56% of all runs were made with a "miss range" of 5 yards or less. Further, the analyzed data revealed an over-all average error of 7 yards. The standard deviation of these data was computed to be 6 yards. The average sonar range from triplane to vectoring ship was 410 yards and the average sea state 1.5. Of interest is the fact that the percentage of error ("Miss range") expressed as a function of target range was 2%. The data used for this computation is shown in Figure 19. It should be pointed out that the CRT indicator and its associated bezels were designed for use at vectoring ranges of 900 - 1200 yards and therefore the

extremely short target ranges realized tended to amplify the errors with respect to operator interpretation.

Figure 20 is a photograph of the remote CRT indicator. It shows an attack run with the triplane target and sonar transponder as well as the wake from the transponder surface carrier. The transponder can be seen closing the range to the target (a - f), passing the target (g - h), and finally at a range beyond the target (i - l). Range to the target is 500 yards. The transmitted pulse length was 1 millisecond and the transponder pulse length 5 milliseconds.

DISCUSSION

Because of the limited number of runs performed during the first two field tests, the results are considered to be only of a qualitative nature. However, the results of these tests indicate that it may be feasible to vector a transponder-carrying vehicle within contact weapon range about one-half the time, and within certain Mark 43 torpedo effective range most of the time even with unfavorable sonar conditions and with relatively unmaneuverable surface ships as the sonar carriers. Under more favorable conditions, with the system entirely airborne in helicopter platforms and additional personnel training, it is believed that the percentage of direct hits can be made to approach 100% at ranges up to 1000 yards. At ranges 1000 yards and less, excellent target aspect echoes are obtainable with short-pulse transmissions, making it possible to vector the transponder carrier to a particular part of the target, or to direct the weapons carrier to the most desirable position with respect to the target for active torpedo drops.

These tests showed that this type of equipment operating at short pulse lengths is capable of supplying excellent short-range classification and attack information which could be useful in destroyer-type fire-control equipments, as well as being used to vector a sonar transponder to a target. Target course to ± 5 degrees is instantly available as is target range and bearing, which can be used to correct fire-control equipment as the attack progressed. Target depth unaffected by thermal-gradient errors is available when the target is within 15 degrees of beam aspect. Target length can be accurately measured and highlight echoes obtained when the target is at other than beam aspect. Both of these indications are excellent classification aids.

Because of the difficulties encountered in the hoisting of the sonar boom, this type of transducer suspension is not satisfactory for helicopter use at the present time. However, because of the potential advantages of this

type of training system for precision types of airborne-sonar systems such as this vectoring system, or mine locating gear, which does not require a variable depth transducer, further investigation and development work should be carried out to find and overcome the causes of these difficulties. Following the second field tests, it was decided that additional field time was required to determine quantitatively the system's vectoring capability. However, owing to the lack of sufficient on-station time with a controlled submarine target this plan was not carried out. In lieu of this, the final field operations served to show the position location accuracy of this system. As has been previously mentioned, 76% of all attack runs were made with an error or "miss range" of 10 yards or less. Also, it was found that the actual error tended to decrease as the target range increased. The average error expressed in percentage as a function of target range, was computed to be about 2%. The fact that these good results were obtained with five different men as sonar operators again indicated that operators for this type of system would require a minimum amount of training.

The Commander Operational Development Force made the following comment in letter FF 5-7/S68 of 3 May 1955 concerning this project:

> "It is concluded that the Sector Scan Indicator is most desirable in airborne sonar systems and that the idea of a search helicopter vectoring an attack helicopter for target 'pinpointing' is feasible".

CONCLUSIONS

The most important conclusions drawn from the three previously described field tests of the NRL Two-Helicopter SSI Attack Sonar System can be summarized as follows:

I. This system has excellent short-range classification capabilities.

II. Precise sonar information is readily available for new fire-control equipments.

III. Accurate vectoring of a transponder carrier is feasible from a sonar carrier.

IV. An increase in hit percentage with both active and passive ASW weapons is to be expected using these techniques.

V. A minimum amount of sonar operator training is required, because of the pictorial presentation.

RECOMMENDATIONS

It is recommended that the classification and attack features of this system be put to use, at least as aids, in present or proposed sonar equipments. The quantitative information then could be obtained under more realistic operating conditions, and the improvement in classification and attack more precisely determined.

It is also recommended that the underwater attack guidance feature of this system be further exploited at lower frequencies in an attempt to solve the long range attack problem, that is, attacking from sonar information in ranges in excess of 10,000 yards.*

*Being considered under NRL Problem 55S05-14

Basic Systems Parameters

Frequency of Operation	20 kc
Transducer, Beamwidth -10 db points	26 degrees
Directivity Index	21.6 db
Bandwidth -3 db points	400 cps
Source Level	115 db re 1 μbar at 1 yd.
Driver Power	650 watts
Displays 1	Audio
2	SSI
3	Doppler (ACAP)
Receiving Bandwidth, Audio	500 Cycles
SSI	500 to 5000 cycles
Pulse Lengths	0.1 to 100 ms

Transponder

Frequency of Operation (adjustable)	20 kc $\pm$ 200 cps
Driver Power	100 watts
Pulse Lengths	1 - 50 ms
Source Level	90 db re 1 μbar at 1 yd.

TWO HELICOPTER ATTACK SYSTEM

VEHICLE REQUIREMENTS: TWO ASW TYPE HELICOPTERS WITH RADIO COMMUNICATIONS:

#1 CARRIES ATTACK SONAR SYSTEM

#2 CARRIES WEAPON AND TRANSPONDER

ASSUMPTIONS: INITIAL DETECTION MADE BY:

1. SIGHT FROM AIRCRAFT
2. RADAR
3. LONG RANGE SONAR
4. HELICOPTER SCREEN

I. HELICOPTER #1 ESTABLISHES CONTACT.

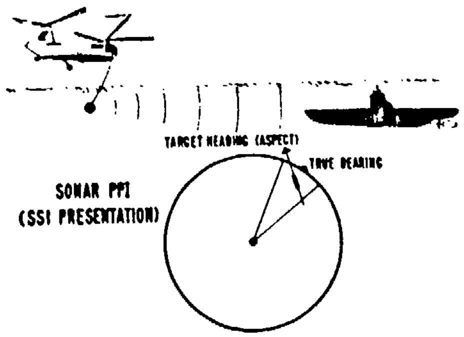


Fig. 1 - Initial contact

II HELICOPTER NO. 2 IS VOICE VECTORED IN ON THE TRUE SONAR BEARING OVER HELICOPTER NO. 1 & LOWERS TRANSPONDER ABOUT TWO-THIRDS OF WAY TO TARGET.

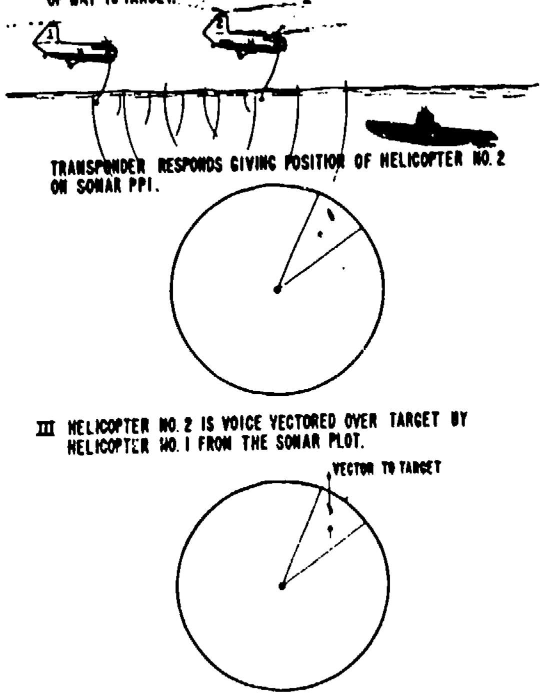


Fig. 2 - Vector procedure

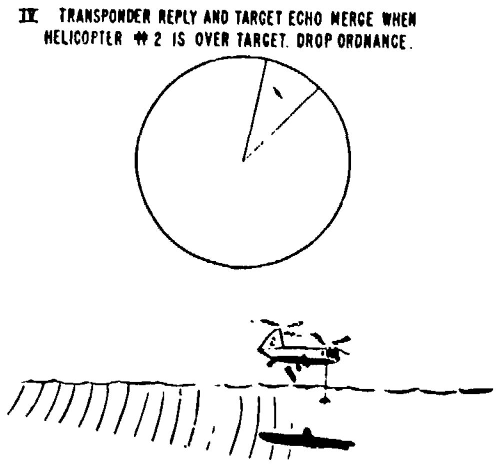


Fig. 3 - Target-transponder coincidence

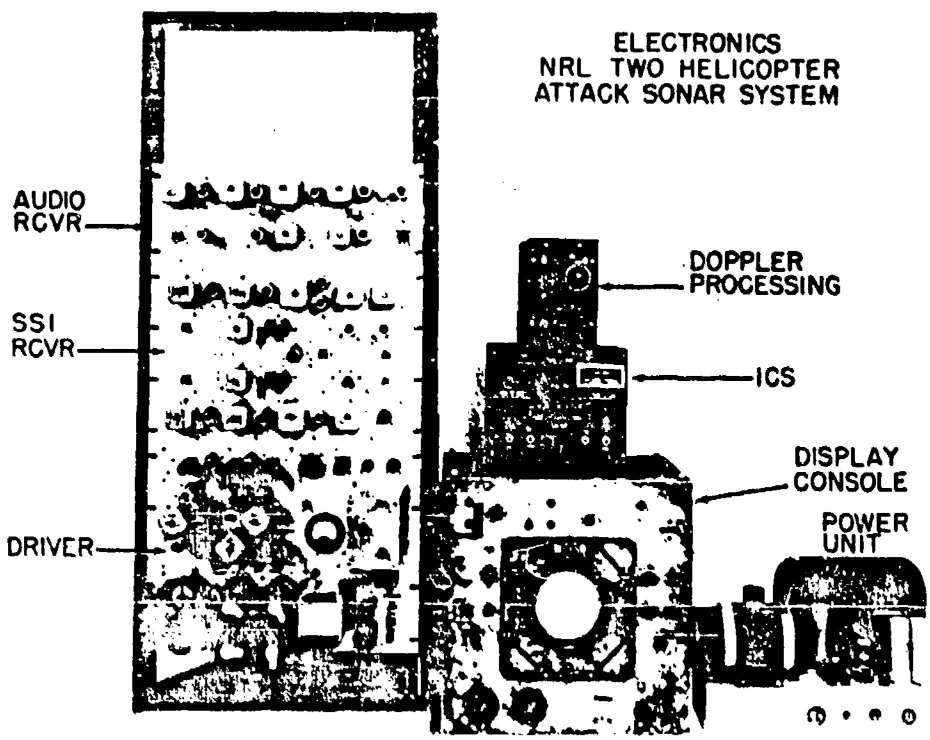


Fig. 4 - System electronic units

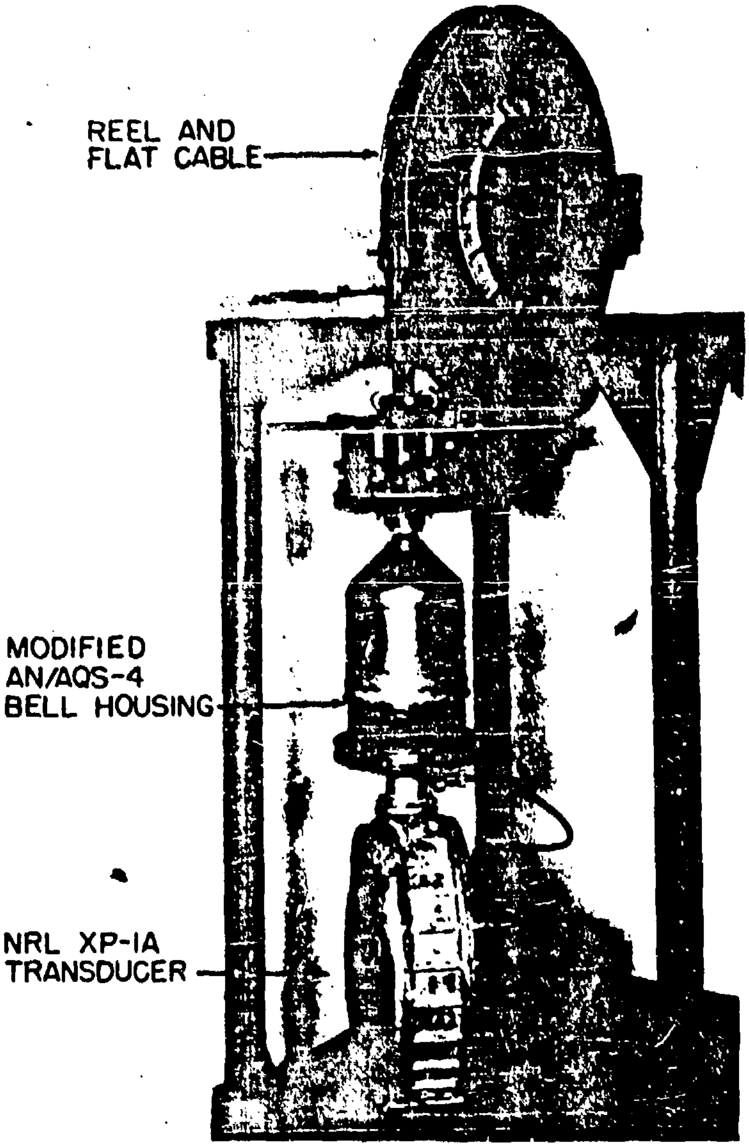


Fig. 5 - Reel and flat cable assembly
NRL attack sonar system

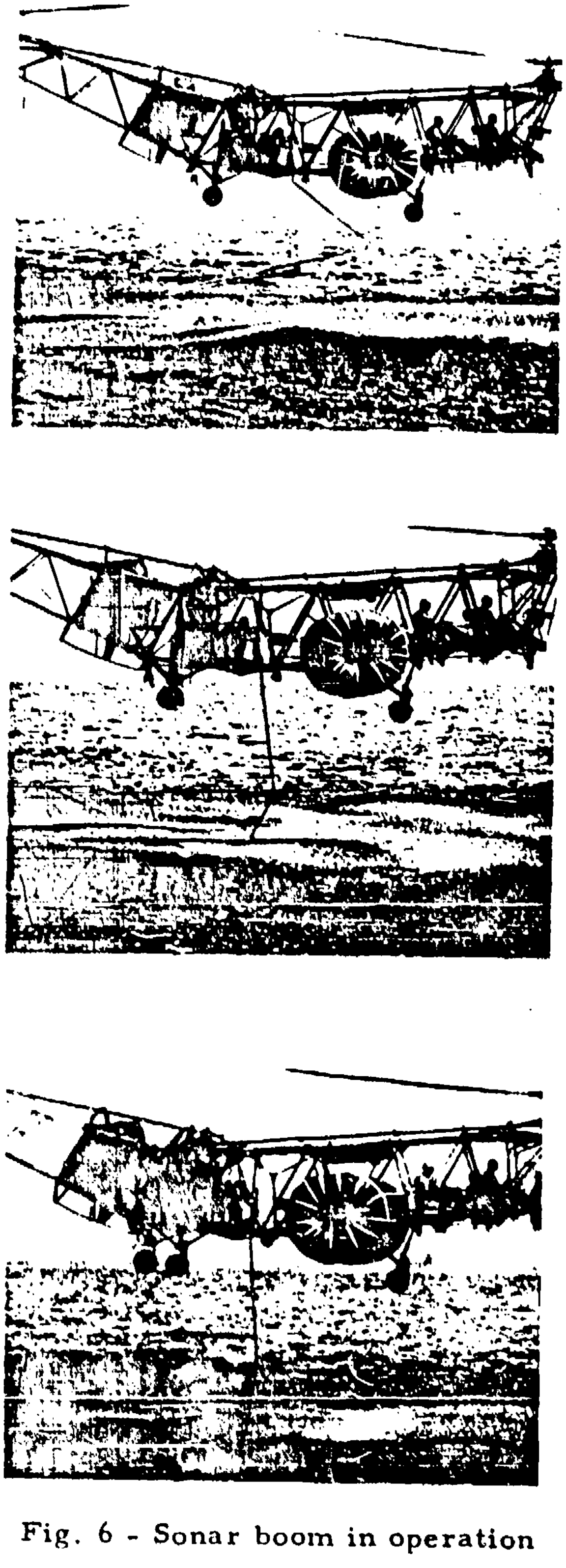


Fig. 6 - Sonar boom in operation

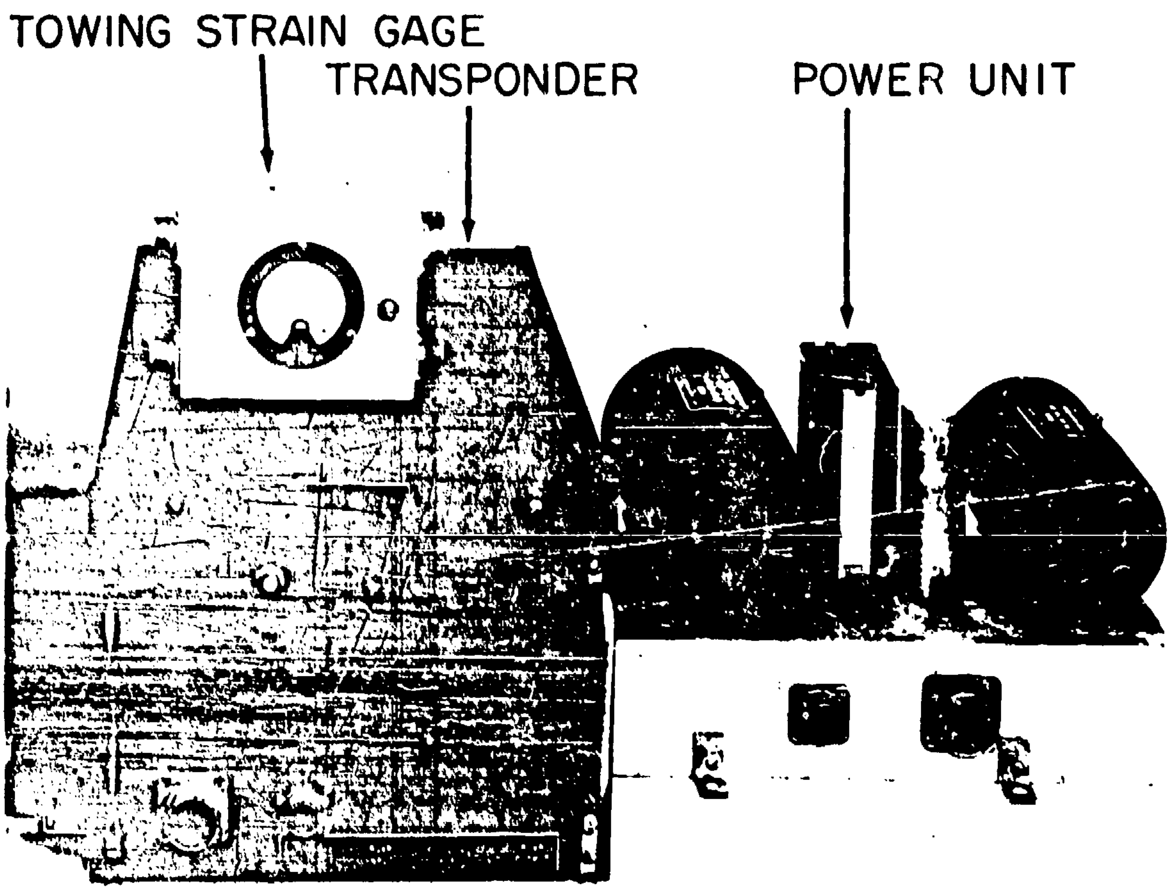


Fig. 7 - Transponder electronics NRL attack system

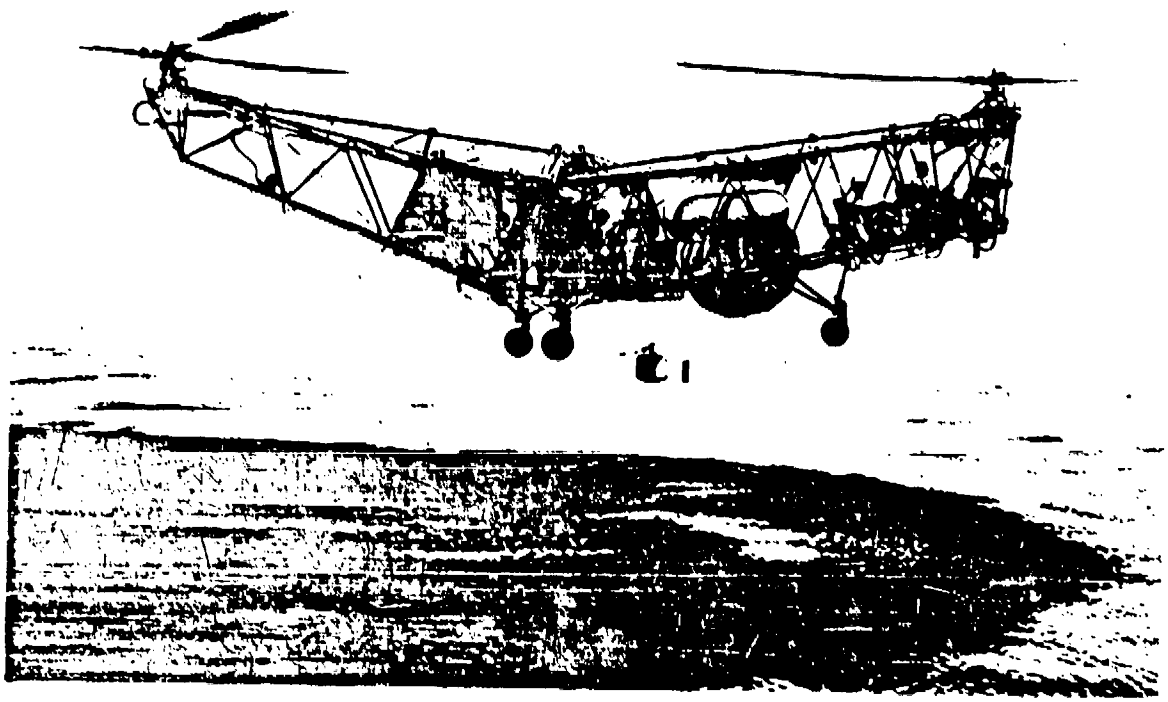
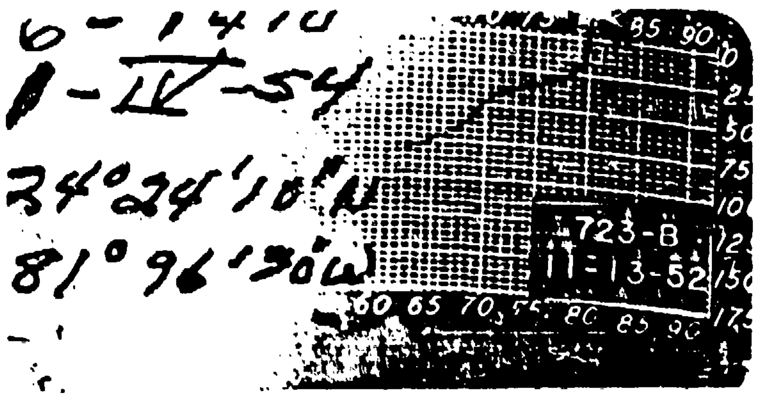
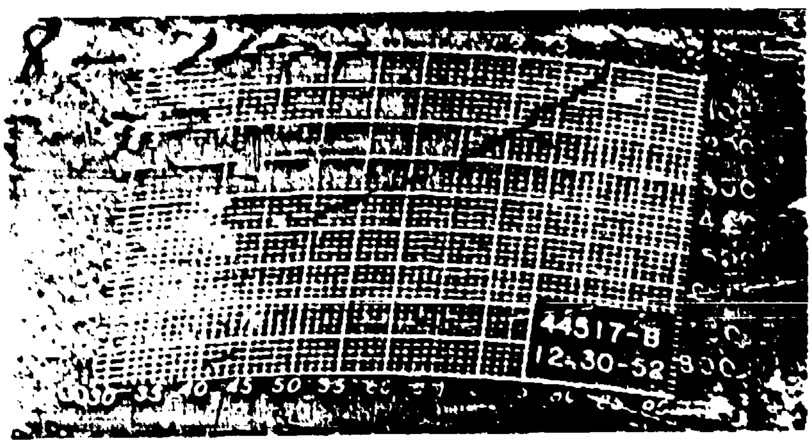


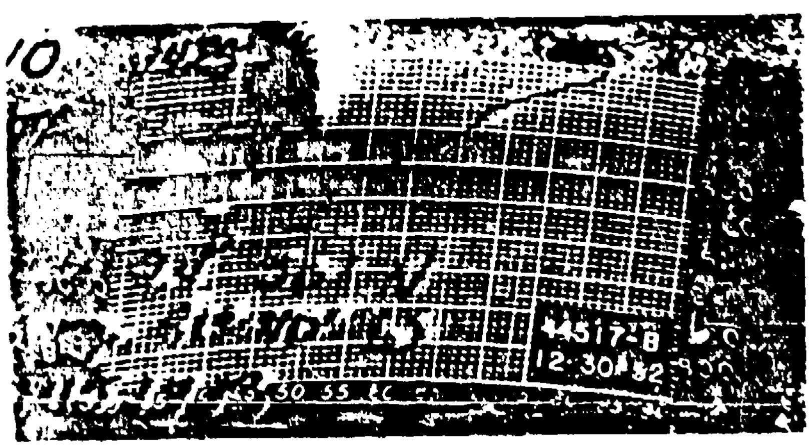
Fig. 8 - Transponder helicopter in a hover, ready to lower fish



1 June 1954



3 June 1954



7 June 1954

Fig. 9 - Bathythermograph charts typical of the period 1 through 10 June in area 6 B

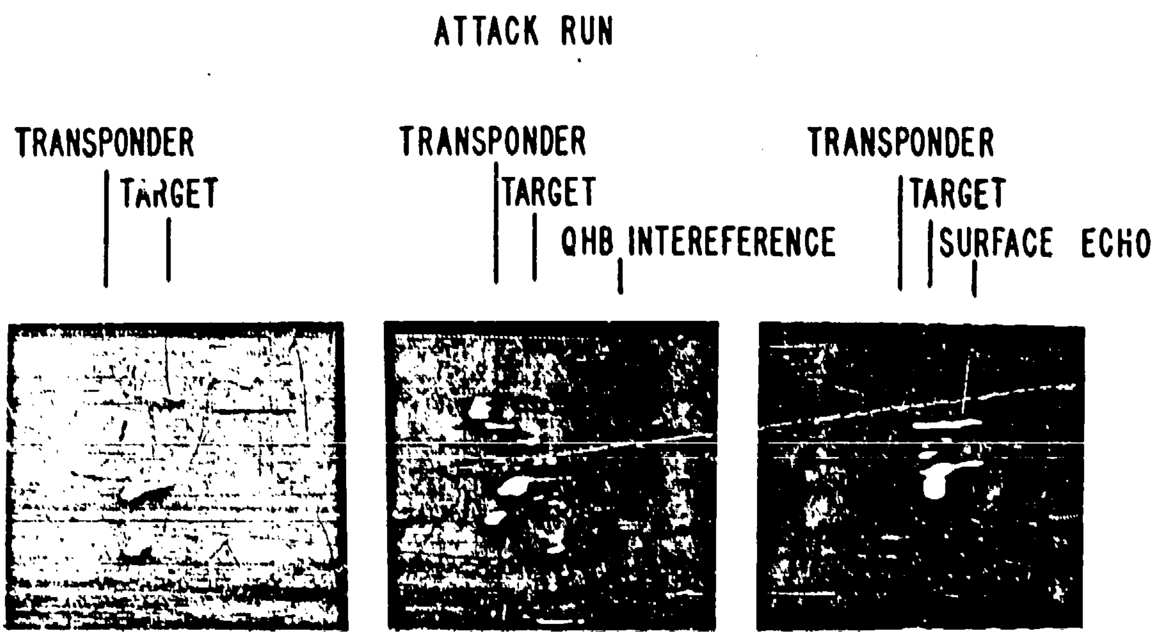


Fig. 10 - Transponder and submarine echoes, NRL attack sonar system. Pulse lengths: 10 milliseconds; Target range 800 yards.

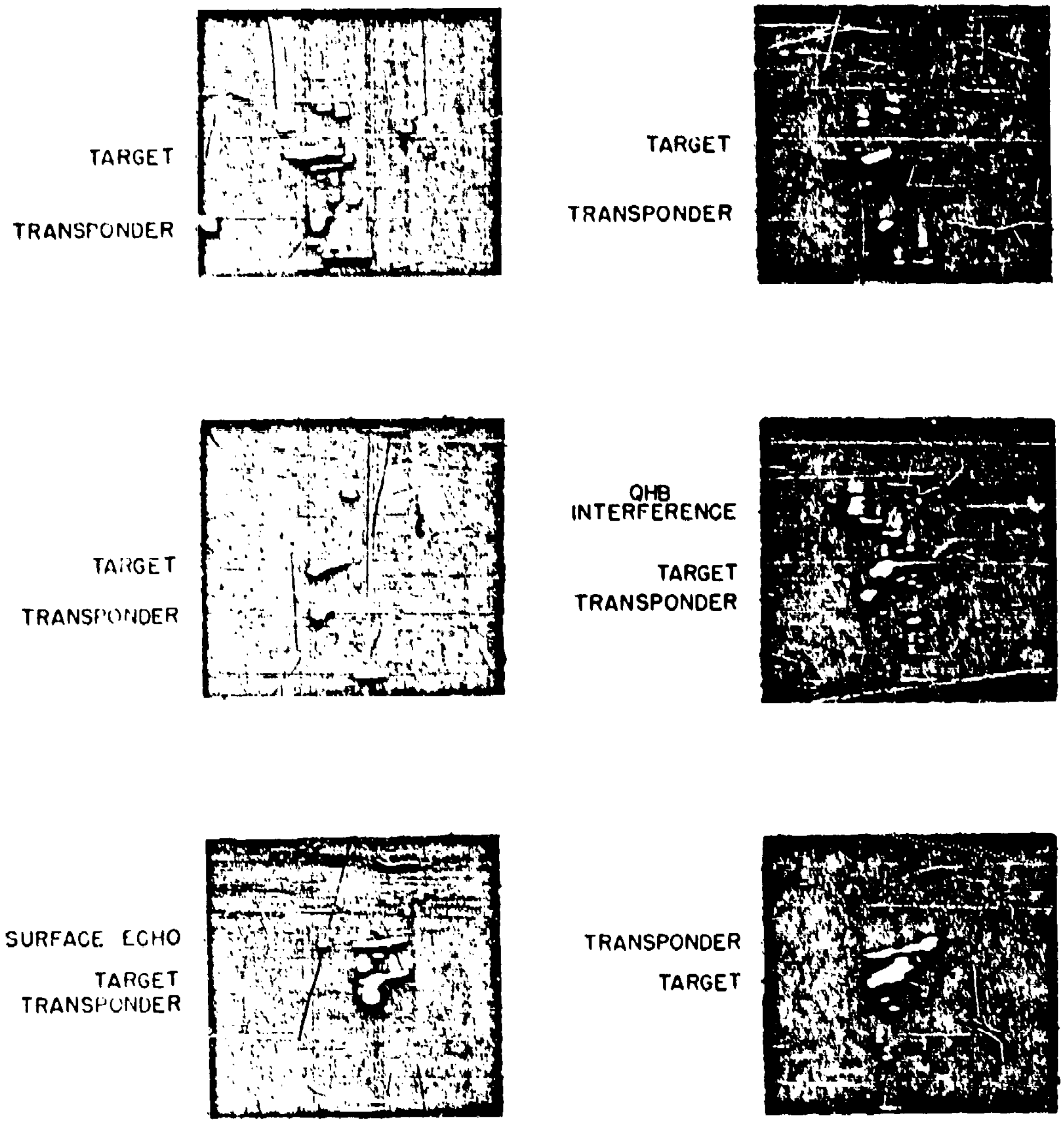


Fig. 11 - Attack run on a beam target at a marginal range of 800 yards

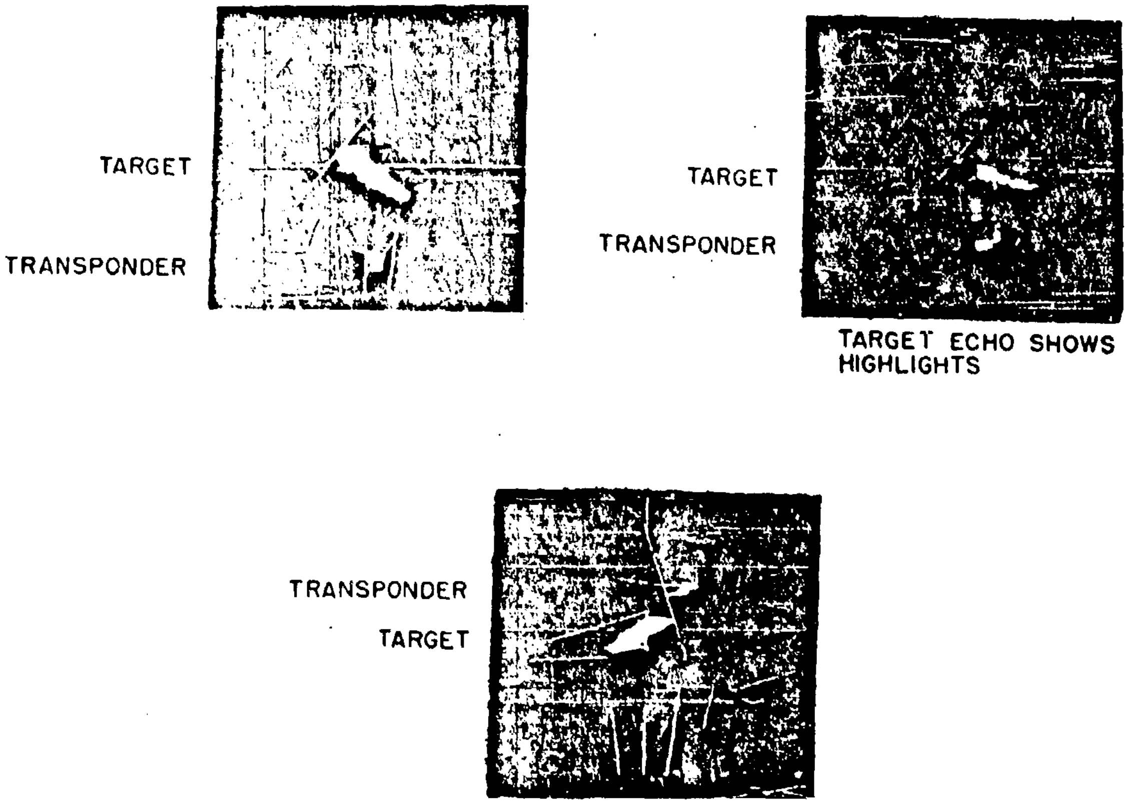


Fig. 12 - Target and transponder echoes, target at a range of 500 yards, pulse length 5 ms

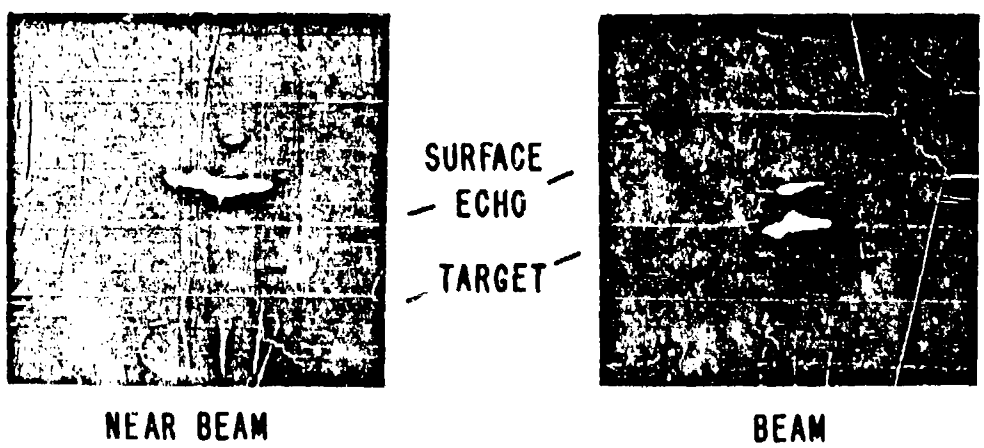
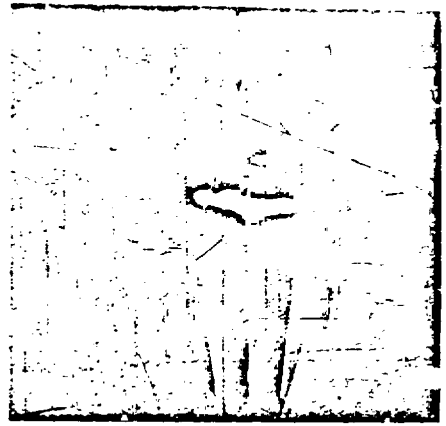


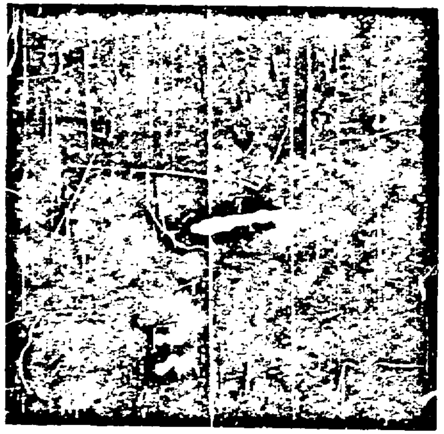
Fig. 13 - SSI surface echo presentations. Pulse length: 3-5 milliseconds: Range: 500 yards

Target Angle 296^{0}
Range to Bow 450 yards
Pulse Length 5 ms

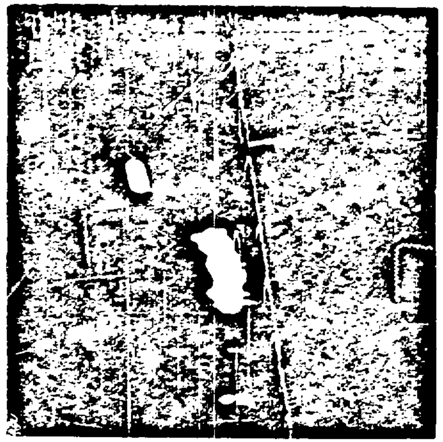
Target Angle 65^{0}
Range to Bow 400 yards
Pulse Length 5 ms



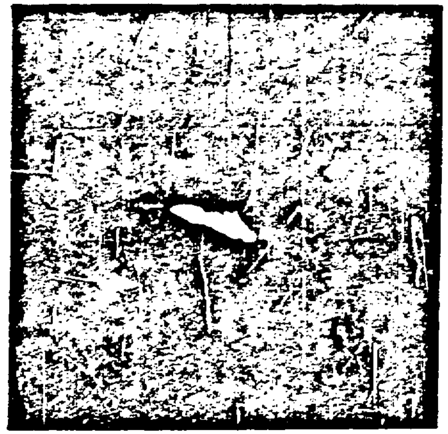
Target Angle 82^{0}
Range to Bow 500 yards
Pulse Length 5 ms



Target Angle 92^{0}
Range to Stern 650 yards
Pulse Length 3 ms



Target Angle 196^{0}
Range to Stern 600 yards
Pulse Length 5 ms



Target Angle 248^{0}
Range to Stern 600 yards
Pulse Length 3 ms

Fig. 14 - Typical aspect presentations

QHB INTERFERENCE

Fig. 15 - Typical highlight SSI presentations from a submarine target. Pulse length, 3 ms: target angle, 240°; Range, 600 yards.

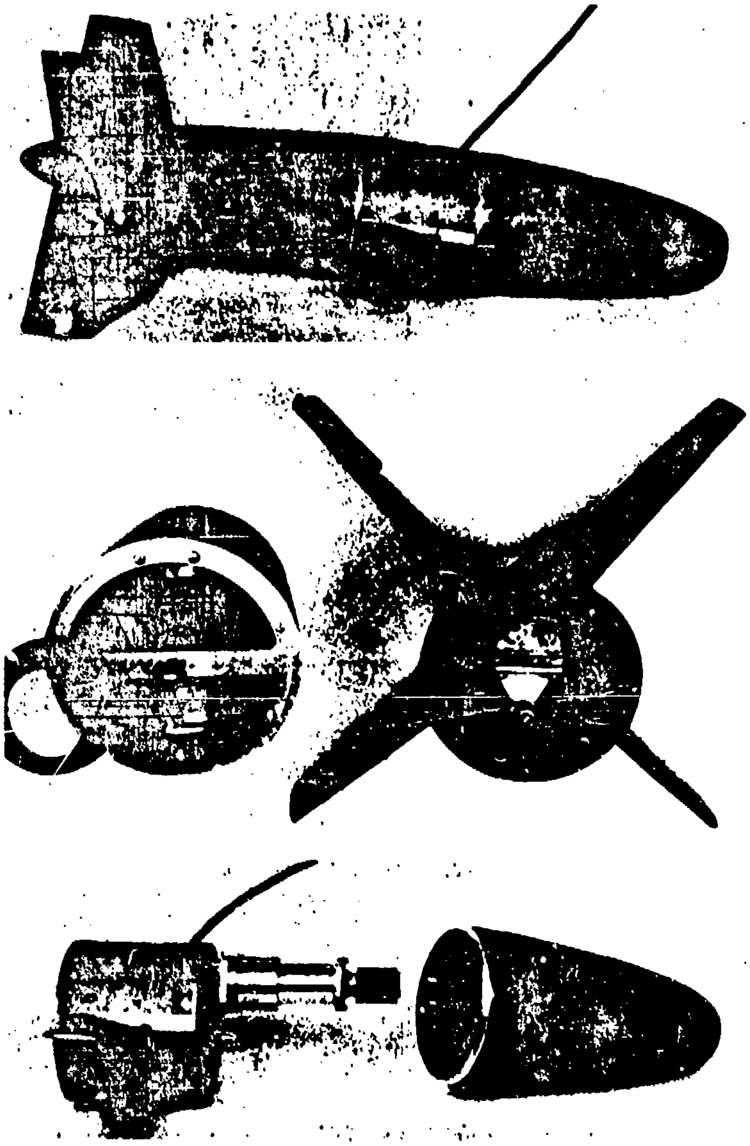


Fig. 16 - High-speed transponder fish

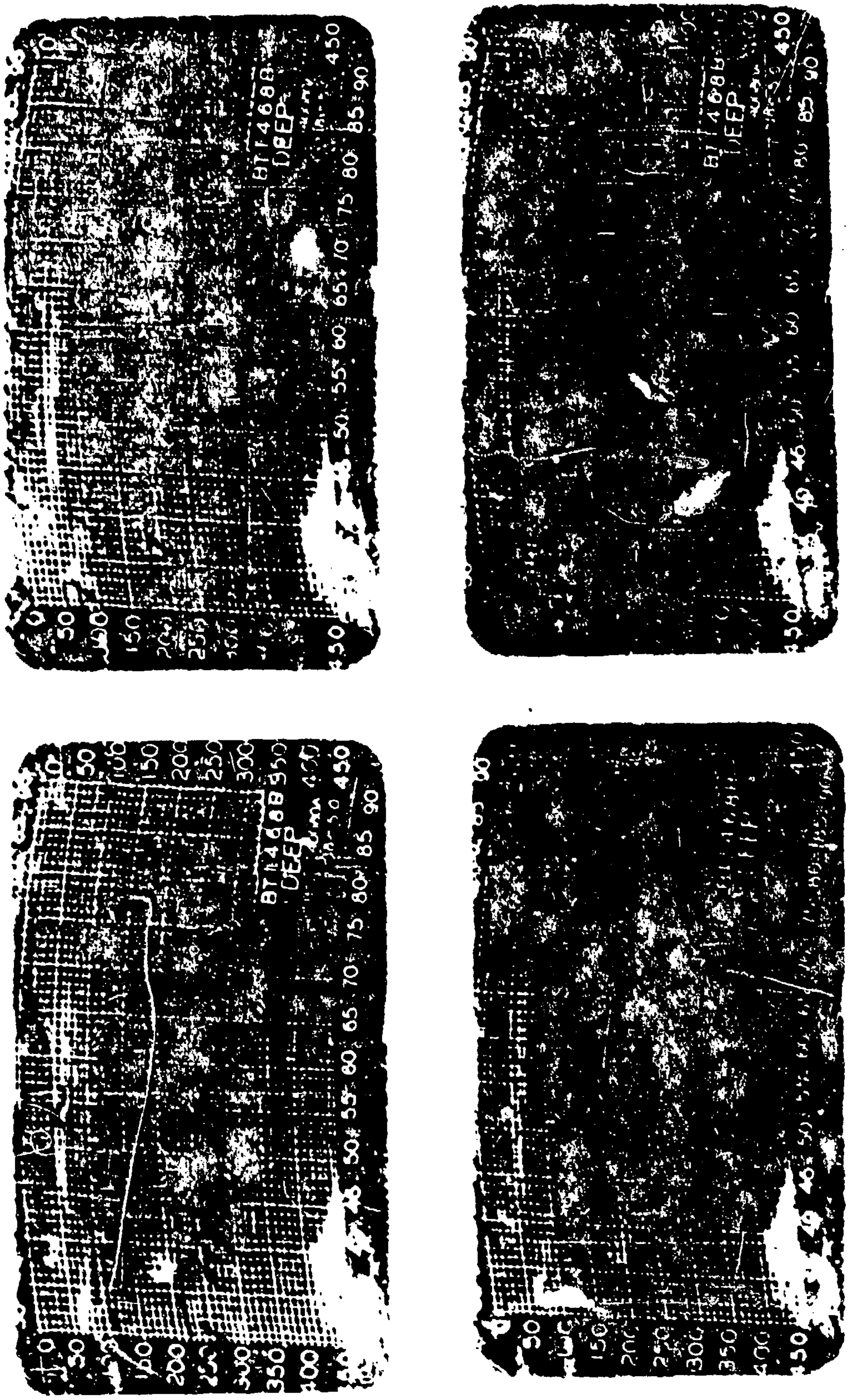


Fig. 17 - Bathythermograph charts typical of period 1-10 March 1955

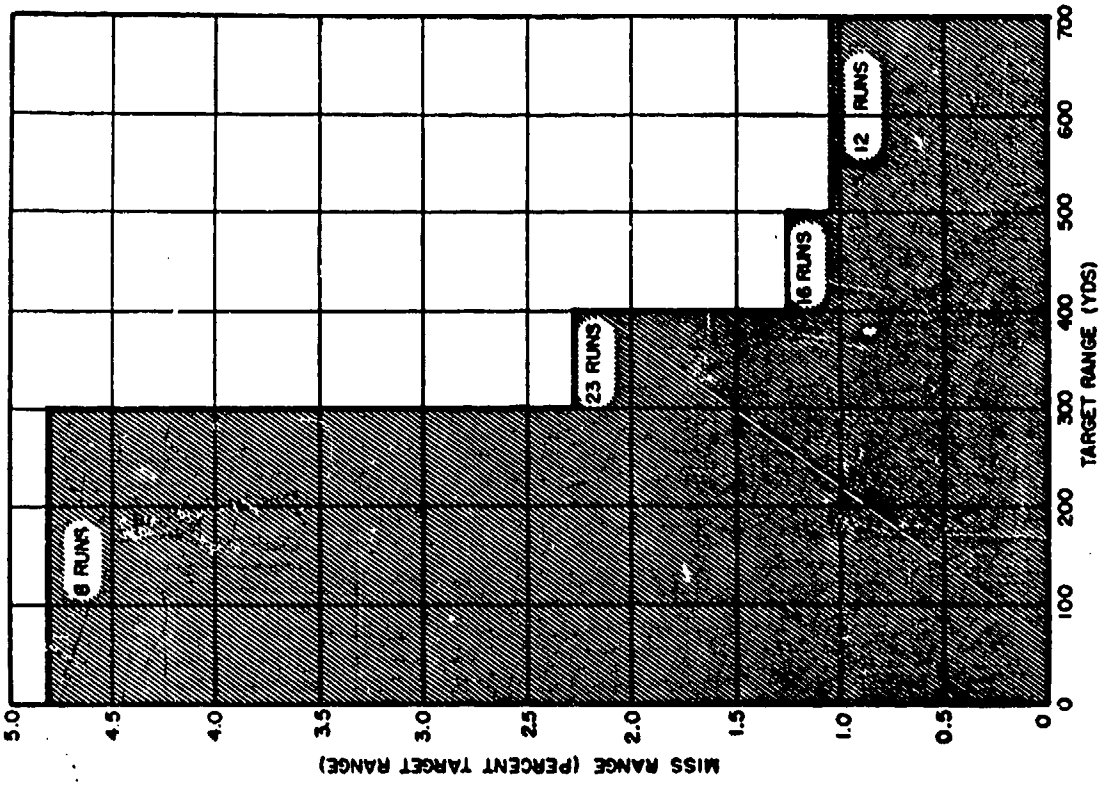


Fig. 19 - Target range vs. miss range

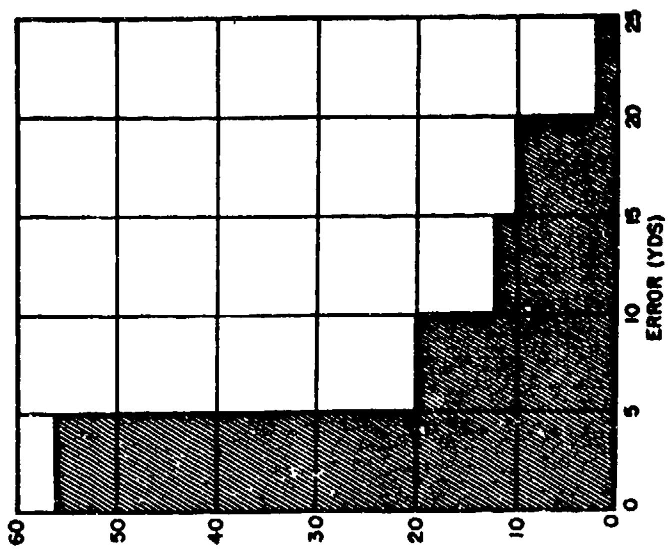


Fig. 18 - Percentage of runs vs. error (yards)

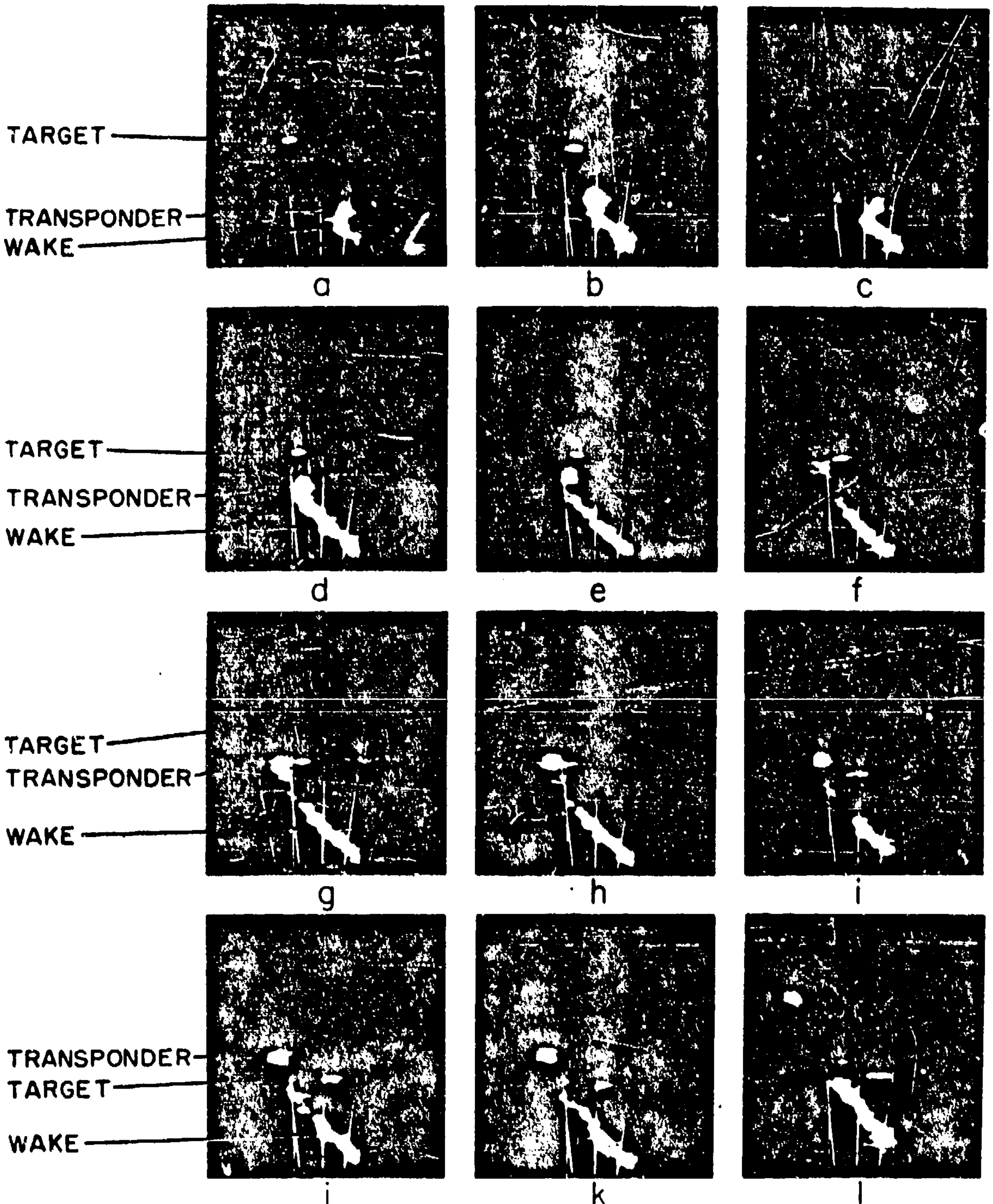


Fig. 20 - Photographs taken from remote scope during run No. 56

UNITED STATES GOVERNMENT

memorandum

7103/114

DATE: 23 October 1996

FROM: Burton G. Hurdle (Code 7103)

SUBJECT: REVIEW OF REF. (a) FOR DECLASSIFICATION

TO: Code 1221.1

VIA: Code 7100

AD-077 449

REF: (a) NRL Confidential Report #4642 by L.C. Ricalzone et al, Oct. 14, 1955 (U)

1. Reference (a) is an ASW operational attack method employing two helicopters. One of the helicopters has a sonar system utilizing the Sector Scan Indicator (SSI) with the second helicopter deploying an acoustic transponder and attack ordinance. The report includes the operational method, the electronics required and a series of operational experiments.

2. The technology and equipment utilized in reference (a) have been superseded several times.

3. Based on the above, it is recommended that reference (a) be declassified with no restrictions.

Burton G. Hurdle

BURTON G. HURDLE
Acoustics Division

CONCUR:

SDPalmer for 10/23/96

EDWARD R. FRANCHI Date
Superintendent
Acoustics Division

Completed
2-7-2000
B.W.

OPTIONAL FORM NO. 19
(REV). 1-80)
GSA FPMR(41 CFR) 101-11.6
5010-114